PURCHASING AND SUPPLY CHAIN MANAGEMENT COSTING: AN AIR TRANSPORT PERSPECTIVE DERIVED THROUGH COMMERCIAL AIR CARGO FIRMS

THESIS

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Abstract

The Air Force has struggled to completely understand the costs associated with its operations. The issue of understanding cost is complex, involving many perspectives, methods and techniques. When examined from a broad standpoint, total supply chain costs can include a firm's costs plus upstream and downstream costs. This perspective takes vendors, suppliers and end customers into consideration. From this broad standpoint, the Air Force does not know its total supply chain cost. Since the Air Force's supply chain is too broad to be a focus of this study, a smaller segment was chosen for a closer look. Specifically, air cargo carriers were selected as a type of commercial organization that could be sufficiently similar to the Air Force in some respects and possibly offer information to address the investigative questions. The purpose of this research is to determine what costing issues exist in the air cargo arena and what costing methods or techniques are utilized to address those issues. Air cargo carriers were contacted and a telephone interview was administered to strategic key informants. The interviews were exploratory, comprised of open-ended questions about how they calculated their cost information, what problems or issues arose from their chosen method and how they addressed those issues. The results of this study may assist the Air Force in determining methods or techniques to address some it's costing issues.

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Kurt Ettrich

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AN AIR TRANSPORT PERSPECTIVE DERIVED THROUGH

COMMERCIAL AIR CARGO FIRMS

I. Introduction

Overview

The Air Force has struggled to completely understand the costs associated with its operations. The Air Force's bottom line is mission accomplishment as opposed to profit, but the Air Force needs to comprehend its costs for a number of reasons. First, the Air Force must manage efficiently and effectively a finite amount of appropriated fund dollars each fiscal year. Second, certain limitations govern the use of appropriated funds such as the restriction on the percentage of dollars outsourced for depot level maintenance (10 USC 2466). Finally, if the Air Force can control it's spending through an understanding of costing, it may improve cash spin (Bowersox, Closs & Cooper, 2002), thus achieving more "bang" for the taxpayer "buck."

The issue of understanding cost is complex, involving many perspectives, methods and techniques. For example, managerial accounting supports decision making while cost accounting supports reporting requirements.

When examining cost and costing techniques or methods, one perspective that can be used is to focus on a specific organization or sub-component such as a strategic business unit (SBU). This perspective can be flawed, however, because it ignores the broader context of the supply chain in which the firm exists. There are costs all along the supply chain and for a method to be completely reliable, it must analyze all these costs. As these costs are observed and potentially manipulated, we move into what's known as supply chain management.

> Supply chain management (SCM) is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system wide costs while satisfying service level requirement. (Simchi-Levi et al. 2003).

The purchasing, or procurement, function deals with processes such as demand planning, purchasing, contract writing, supplier base management, individual vendor management, business practices, budgeting, and customer relationships. Purchasing has recently been considered part of the overall supply chain since it is such an integral component when viewed from a comprehensive perspective (Monczka, Trent & Handfield, 2002). The role of purchasing in supply chain management is frequently referred to as PSCM or purchasing and supply chain management.

A primary focus of supply chain management is the minimization of system wide costs in which cost is associated with every function of the

supply chain from forecasting future demand to final disposition of the product, or in other words, from “end-to-end” (Simchi-Levi et al. 2003). Clearly, it is crucial to understand these costs as well as the methods available to calculate them if efficiencies such as cost savings are to be achieved.

The Problem

When examined from a broad standpoint, total supply chain costs can include a firm’s costs plus upstream and downstream costs. This perspective takes vendors, suppliers and end customers into consideration. From this broad standpoint, the Air Force is unable to accurately characterize its total supply chain cost, whether at the Air Force level, the command level (e.g., Air Force Materiel Command (AFMC), which performs a large portion of the Air Force’s purchasing, acquisition and maintenance), or even the Air Logistics Centers (ALC) or depot level. This is important because the Air Force can’t quantify potential future cost savings without knowing how much is currently being spent, or more specifically, where and how it’s being allocated. Part of the reason the Air Force doesn’t calculate this figure is it hasn’t yet identified an appropriate and valid total supply chain cost model or definition.

Since the Air Force is engaged in a comparatively rare set of functions (i.e. warfighting), and since multiple functions are required to support multiple aircraft and various pieces of equipment at numerous locations, it becomes difficult to simply take a generally accepted cost model and use it

for the Air Force's purposes. The Air Force needs to adapt a method or model that will help the ALC's, AFMC, and ultimately the Air Force, to understand the costs associated with the supply chain from a comprehensive viewpoint, thus enabling operations to be more efficient (i.e., in terms of cost) while maintaining necessary levels of effectiveness.

Since the Air Force's supply chain is too broad to be a focus of this study, a smaller segment was chosen for a closer look. The segment considered was aircraft operations. The Air Force routinely utilizes aircraft to move cargo from one location to another. There are commercial firms that also utilize aircraft in their operations. Specifically, air cargo carriers were selected as a type of commercial organization that could be sufficiently similar to the Air Force in some respects and possibly offer information to address the investigative questions.

Research Questions

The previous discussion suggested that understanding costs and costing techniques is important when it comes to managing the supply chain. That leads to the following research questions: What costing techniques are currently being utilized by air cargo carriers and why? What are the possible implications for the Air Force?

Investigative Questions

The overarching research questions lead to the following investigative questions:

- What costing techniques are currently available?

- What are the key issues in transportation service costing?

- What are the transportation service costing issues faced by air cargo carriers?

- How do these firms address those issues?

- Why are these issues addressed that way?

- What is the relevance to the Air Force of these issues and how they're addressed?

Methodology

The methodology started out with a thorough literature review regarding the techniques or methods to calculate costs as well as the issues surrounding costing. Air cargo carriers were then contacted and a telephone interview was administered to strategic key informants. The interviews were exploratory, comprised of open-ended questions about how they calculated their cost information, what problems or issues arose from their chosen method and how they addressed those issues.

Thesis Overview

This chapter provided a brief introduction and an overview of the study. The rest of the thesis is structured as follows: Chapter Two contains background information and a review of relevant literature; Chapter Three contains the methodology of what data was collected and how it was collected; Chapter Four follows with an analysis of the data; and Chapter Five presents an overall discussion of the findings, draws conclusions based on the discussion, reviews limitations of the study and makes appropriate recommendations for research and practice.

II. Background

This chapter reviews the literature relevant to the study. It is organized topically and looks first at some background information regarding the Air Force's concern with costing. It then explores costing methods and costing issues.

Air Force Interest

Title 10 of the United States Code includes the so-called 50-50 rule that governs outsourcing. This rule requires that a defense agency or military department can outsource no more than 50-percent of the appropriated funds earmarked for depot-level maintenance (10 USC 2466). Although the Department of Defense (DoD) is required to submit reports to the Congress regarding depot maintenance costs, the General Accounting Office (GAO) also has the responsibility of reporting to the Congress on whether DoD complied with the 50-50 rule. According to the GAO's 2002 report, the Army and Navy were below the 50-percent funding limitation for outsourcing, thus meeting the goal. The Air Force, however, was above the 50-percent limitation (GAO-03-16, Oct 2002). The Air Force's inability to comply with Congressional direction has caused concern within Congress about how the Air Force tracks costing.

The Air Force maintains three Air Logistics Centers (ALC's), otherwise known as depots, that exist to perform periodic maintenance, system upgrades and overhaul capabilities for major weapon systems. All three fall

under the Air Force Materiel Command (AFMC), a major command (MAJCOM) headquartered at Wright-Patterson Air Force Base (AFB) near Dayton, Ohio. In order to comply with the 50-50 rule, the Air Force has had to take a close look at its maintenance operations and its supply chain, specifically at the ALC's. For the Air Force to become the preferred supplier to the warfighter and reduce its current level of outsourcing, the Air Force supply chain needs to become more efficient, more effective, and realize a cost savings.

The commercial sector has attempted to demonstrate that adopting purchasing and supply chain management (PSCM) "best practices" may help produce radical improvements such as decreased costs, increased efficiency and increased effectiveness. No single method has emerged as the panacea for every situation. Nonetheless, there is a widespread perception that some efficiency, effectiveness, and cost savings may flow from some form of PSCM implementation.

The Air Force anticipates certain PSCM practices may contribute to success in areas such as demand planning; purchasing; inventory management; supplier base management; business practices; and customer relationships. The Air Force is specifically interested in possible cost savings believed to be associated with PSCM. The Air Force wants to assess PSCM best practices and determine how to apply them to sustainment and operational activities.

The Spares Campaign, an initiative sponsored by the Air Force's Supply Chain Integration & Logistics Transformation Office (AF/IL-I) and endorsed by the commander of AFMC, strives to ensure the improved

availability of spare parts to the warfighter when and where they are needed. As a key component of the Spares Campaign, PSCM best practices could play a role in streamlining this process and making it more efficient and effective. Needless delays caused by back ordered parts can result in cannibalizing the needed parts from another operational weapon system. While this may be a temporary fix, cannibalization is a symptom of the larger problem which is lack of timely re-supply of spares. The Spares Campaign attempts to focus on a longer term view to resolve the issue.

HQ AFMC/PK, the contracting staff for Materiel Command, is trying to ascertain how to improve the Air Force Supply Chain and has an initiative in progress to examine PSCM. An Executive Steering Group has been established to examine multiple facets of PSCM with respect to the Air Force. (See Figure 1)

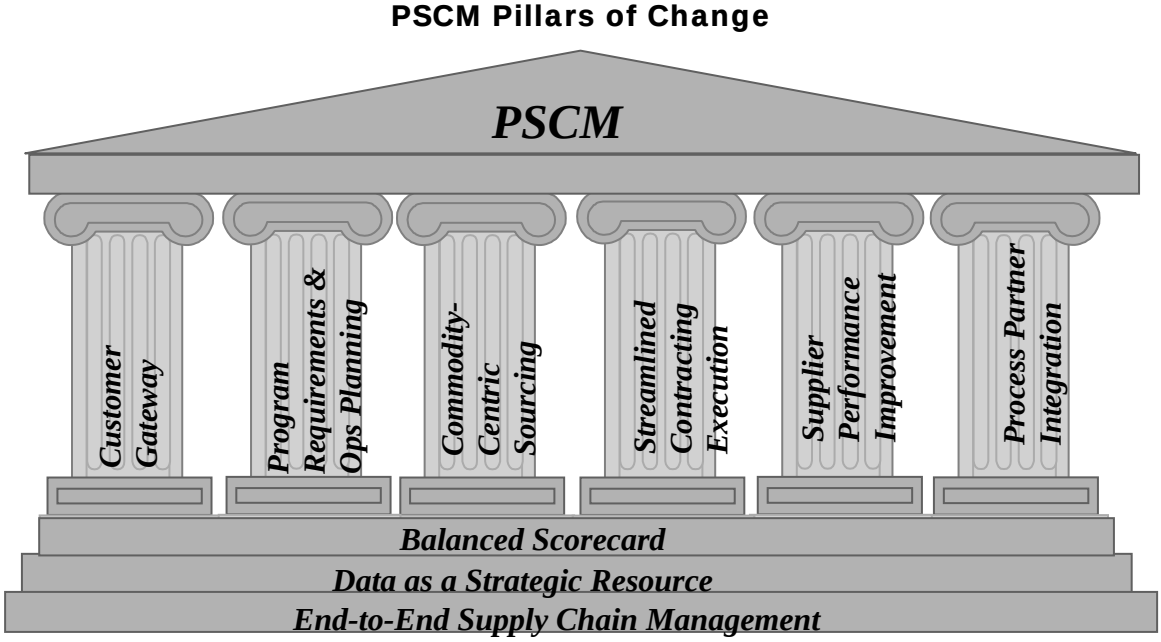

Figure 1. Taken from a PSCM Executive Steering Committee Presentation entitled *PSCM Pillars of Change*

The notion of an “end-to-end” supply chain serves as the foundation for the Air Force PSCM construct. This foundational element must be clearly understood if the Air Force is to be capable of manipulating its supply chain to efficiencies and cost savings. In order for the Air Force to truly realize a cost savings, it must determine three things:

1. Where are we now (how much are we spending, where? on what?)?
2. Where do we want to be (how much can we cut)?
3. How do we chart a course to get there (how do we do it)?

Step 1 would require the Air Force to identify its current “total supply chain cost.” Since there are multiple definitions and models of “total supply chain cost,” (Bowersox, Closs & Cooper, 2002; Frazelle, 2002; Monczka, Trent & Handfield, 2002; Stock & Lambert, 2001) and total supply chain costs would be too broad in scope, this study seeks to identify the methods or techniques to calculate cost and the issues or problems associated with those techniques. Specifically, the air cargo sector was chosen as a focus for this analysis.

Air Force Costing

The primary number that serves as a baseline in the Air Force is Cost Per Flying Hour (CPFH). Since the Air Force flies multiple airframes, CPFH is calculated by aircraft type, and is further customized by MAJCOM but that level of refinement isn’t required for this thesis. CPFH is calculated using four factors:

1. ***System Support Division*** (SSD) – disposable aircraft parts, antennas, lights, wiring, windshields, etc.
2. ***General Support Division*** (GSD) – other expendable items which include common bench stock items, administrative supplies, tools, etc.
3. ***Depot Level Reparables*** (DLRs) – aircraft parts removed by wing maintenance personnel and sent to depots for repair.
4. ***Aviation Fuel*** (AVFuel) –Fuel used during flight, which typically includes JP-4, JP-8, off-station fuel and in-flight refueling. The AVFuel factor is expressed in gallons per hour, which is converted into a dollar per hour factor based on DoD established prices for each fuel type.

(Rose, 1997)

Numbers one and two fall under a broader category called Consumable Supplies, so at times, CPFH may be referred to as having three categories instead of four.

The Air Force utilizes these four factors to calculate a baseline rate using the most recent numbers for obligations and flying hours. Next, approved adjustments and economic adjustments are made. MAJCOMS recommend approved adjustments annually along with rationalization for the changes. The Air Force Cost Analysis Improvement Group (AFCAIG) applies the economic adjustments which take inflation (or deflation) into consideration. These rates are then used in budget estimation for coming years (Rose, 1997).

Flying Hour (FH) and Primary Aircraft Authorization (PAA) factors are presented in attachments to Air Force Instruction (AFI) 65-503 entitled Cost

and Planning Factors. FH factors are assumed to vary with flying hours whereas the PAA factors are assumed to vary with the number of assigned aircraft (Air Force, 1994). Below is Table 1 which contains an excerpt of AFI 65-503, Attachment A2-1, Logistics Cost Factors Budget Year 2004 (FY 2004 Constant $).

Table 1. Excerpt Logistics Cost Factors Budget Year 2004 (FY 2004 Constant$) (Air Force, 1994).

AFI 65-503	Attachment 2-1 Table A2-1 BUDGET YEAR 04 (FY04 Const $s)						December 2003		
	Per Flying Hour Costs						Per PAA Costs		
MDS	**Consum Supp GSD**	**Depot Level Repar MSD**	**Aviat Fuel**	**IMPAC**	**Depot Maint**	**Total FH Costs**	**Depot Maint**	**Suprt Equip**	**Total PAA Costs**
C-141B	$655	$2,003	$1,924	$17	$736	$5,335	$718,322	$15,228	$733,550
C-141C	$655	$2,003	$1,924	$17	$736	$5,335	$718,322	$6,103	$724,425
C-17A	$171	$64	$2,555	$14	$0	$2,804	$4,575	$16,056	$20,631
C-5A	$1,493	$4,122	$3,235	$41	$1,799	$10,690	$1,275,734	$7,118	$1,282,852
C-5B	$1,493	$4,122	$3,235	$41	$1,799	$10,690	$1,275,734	$12,089	$1,287,823
C-5C	$1,493	$4,122	$3,235	$41	$1,799	$10,690	$1,275,734	$5,737	$1,281,471
KC-10A	$6	$0	$2,545	$10	$0	$2,561	$216	$21,842	$22,058

This excerpt shows figures for the Air Force's primary cargo airlift aircraft, the C-141 Starlifter, C-17 Globemaster, C-5 Galaxy and the KC-10A Extender which is an in-air refueling platform but can also carry cargo.

When Air Force aircraft are used outside the Air Force, for instance, to transport cargo for the Department of the Army, a different hourly rate is utilized. These are called Aircraft Reimbursement Rates and in addition to the four factors listed earlier, it also includes Contractor Logistics Support and personnel costs for aircrew (Air Force, 1994). Table 2 includes an

excerpt from AFI 65-503, Attachment A15-1, Aircraft Reimbursement Rates (per flying hour). The same aircraft types are illustrated.

Table 2 . Excerpt Aircraft Reimbursement Rates (per flying hour) FY2004 (Air Force, 1994).

		REIMB RATES FY04	
MDS	(DOD)	(OTH/FMS)	(PUBLIC)
C-141B	$6,809	$7,128	$7,413
C-141C	$7,143	$7,462	$7,760
C-17A	$4,963	$5,121	$5,326
C-5A	$13,603	$13,892	$14,448
C-5B	$10,690	$10,946	$11,384
C-5C	$10,690	$10,946	$11,384
KC-10A	$7,779	$7,969	$8,288

MDS – Mission, Design, Series FMS – Foreign Military Sales

In addition to the aircraft reimbursement rates are the charges for the actual cargo. The United States Transportation Command (USTRANSCOM) issued the Transportation Working Capital Fund (TWCF) Rate Procedures – Fiscal Year 2003. Specifically addressing cargo are the following criteria:

1. AMC (Air Mobility Command) bills on either a per pound or per pound mile basis. The Office of Under Secretary of Defense Comptroller, OUSD(C), directs AMC cargo rates be commercially comparable. To achieve this, AMC applies a variety of business procedures in establishing appropriate commercial benchmarks. These are as follows:

a. All rates are priced $0.01 per pound lower than existing commercial competition (e.g., tenders, commercial air lines of communication (COMALOC)) whenever possible.

b. Forecasted Channels: If no commercial competition, rates set at 62% overall cost recovery with $1.00 per lb minimum.

c. Non-Forecasted Sequence Listing Channels: If no commercial competition, non-contingency channels set at 85% overall cost recovery and contingency channels set at 91% overall cost recovery.

d. All other channels used during fiscal year will be set at 85% overall cost recovery if there is no commercial competition.

e. Rates vary by weight break (1-439; 440-1099; 1100-2199; 2200-3599; 3600+).

f. Starting in FY02, there is a $1 per pound minimum rate for all routes to help recover fixed costs. There is also a minimum shipment weight billed of 10 pounds per cubic foot and a minimum charge of $25 per shipment to recover fixed costs.

USTRANSCOM TWCF Rate Procedures – FY2003

Since the Air Force is the premier airpower in DoD, other services often request that the Air Force provide airlift capability. Since the Air Force is allocated a limited amount of appropriated fund dollars for it's own operations, the aircraft reimbursement rate and the cargo rate procedure criteria above are used to offset expenditures.

Costing Issues

A search of current literature yielded some current costing issues and methods. To gain a better understanding of the available costing methods, this chapter will briefly explain each one. The first one addressed is traditional cost accounting.

Traditional Cost Accounting

The inherent problems with traditional cost accounting are becoming more glaring. Dugdale (1990) points out that traditional cost accounting is not in step with changes in manufacturing and, in fact, can give the wrong impression about a cost issue. This can directly lead to a manager making the wrong decision about the issue at hand. Since overhead and indirect costs are not traced to specific products or outputs, the true cost of production is never really known. As a result, the selling price may not recover the full cost of the manufacturing process. So while a firm believes it is generating revenue on a product line, it could be losing money.

Activity Based Costing

Authorities have recommended many approaches to measuring cost in an organization. One approach is Activity Based Costing (ABC.) ABC is a technique which involves tracing overhead and direct costs back to specific products and services (Simchi-Levi et al. 2003). MacArthur (1992)

advocates the use of ABC as a more effective approach for tying costs to particular activities within the organization. Firms that field numerous products or services may find ABC especially helpful since complex product offerings can generate complex overhead support activities that require proper allocation (MacArthur, 1992). ABC could enable a more specific and focused look at exactly where some of the costs originate which is one of the more important aspects behind ABC. Where traditional cost accounting deals with an overhead as a single category of expense, ABC attempts to split the overhead up and attach it in some way to an output. The output could be a widget, a service performed such as an oil change or the cost to fly an Air Force C-17 Globemaster for one hour. Once the cost of the output is known, it becomes clearer where management should focus attention in an effort to reduce costs or maximize output.

While ABC offers potential benefits, there are also potential drawbacks. Managers sometimes would like to disaggregate costs that, in reality, exist only in the aggregate. For example, if it costs $3,000 per flying hour to operate a C-17, a savings of $3,000 is not actually realized by not flying. This stems from certain costs such as the salary of the pilot, co-pilot and loadmaster who will be paid whether they fly a mission or sit in an office. So only once the C-17 is airborne can the fixed overhead of salary be traced to that flying hour, which is the output in this case. This example illustrates the importance of selecting appropriate cost drivers that result in an output, so management can fully understand how costs and processes can affect each

other as well as the total cost. See Table 3 below and Table 4 on the next page for an example of the differences between traditional costing and ABC.

Table 3. General Ledger vs. ABC (Harrington, 1995).

General Ledger View of Warehousing Costs		***Activity-based View of Warehousing Costs***	
Storage and Handling	$ 40.10	Dry storage	$ 25.00
General and Administration	$ 30.90	Refrigerated storage	$ 8.10
Trucking and delivery	$ 4.50	Receiving	$ 20.00
Freight Consolidation	$ 2.40	Shipping	$ 18.80
Value-added services	$ 3.30	Billing	$ 3.20
		Delivery	$ 6.00
		Packaging/stenciling	$ 1.80
		Freight consolidation	$ 3.00
		Material handling equip.	$ 5.30
Total	$ 91.20	Total	$ 91.20

Activity based costing unbundles the traditional cost view by responsibility center and restates costs by how resources are consumed and managed.

Clearly, the breakdown of costs on the activity-based side is much easier to trace back to a specific task or output. Beyond being able to trace specific costs is being able to identify significant increases and knowing exactly where the source is located. If a pooled total cost increased dramatically, it may take additional time and effort to break that figure down into its applicable components in order to identify the primary source of the increase. For instance, if refrigerated storage has increased by 15%, the activity-based view would allow us to see that immediately rather than have to break down the broader ‘storage and handling’ category in the general

ledger view. The sooner a problem can be identified, the sooner corrective action can be implemented.

Table 4. Where are costs generated? (Harrington, 1995).

Costing a Department With Activity-Based Management			
Chart of accounts view: ***Receiving department***		***Activity accounting view:*** ***Receiving department***	
Salaries	$120,000	Receive Material	$ 86,600
Supplies	$ 30,000		
Depreciation	$ 20,000	Move Material	$ 84,600
Overtime	$ 15,000		
Space	$ 30,000	Expedite Material	$ 58,800
All Other	$ 15,000		
Total	$230,000	Total	$ 230,000

Figure 3 shows something a little different. There is a $15,000 expenditure for overtime and while that may be a significant increase, it doesn't tell us *why* there was overtime. Management can't take action against 'overtime' per se. If workers were required to perform a task, and the task was completed, that could justify the overtime. However, management will want to understand the cost driver, in other words, what generated the overtime. Perhaps a manager would be able to look at the right hand column and ascertain a normal expediting expense is between $43,000 and $44,000. Evidently, expediting is the cause of the overtime. The manager can now dig deeper to determine if there were inefficiencies, a problem with a supplier or a production glitch.

Direct Product Profitability

Direct Product Profitability or DPP emerged as a costing technique focused on direct costs within the grocery sector during the 1960's and 1970's (LaLonde & Pohlen, 1996). Instead of relying on gross margins to determine profit, DPP took a closer look at specific physical characteristics such as handling, storage, freight and labor required to stock shelves. This was done in an attempt to understand how they impacted profit, merchandising and product-handling decisions (LaLonde & Pohlen, 1996). While this method developed a more accurate picture as to whether a specific product was making or losing money, its downfall is related to the exclusion of overhead or indirect costs (LaLonde & Pohlen, 1996). Any method that fails to address overhead or indirect costs is clearly too narrow and couldn't be utilized on a larger scale to develop a comprehensive awareness of total costs.

Efficient Consumer Response

Efficient Consumer Response (ECR) is not a cost model, but a broad costing technique that focuses on automation and is split into two phases; Phase I is Best Practices Efficient Replenishment and Phase II which is Efficient Replenishment (LaLonde & Pohlen, 1996). Phase I attempts to automate the supply chain within the firm and Phase II builds on Phase I by assimilating the vendors and distributors into the supply chain to create a larger, cohesive, automated cycle (LaLonde & Pohlen, 1996).

While this method is primarily centered on efficiency, as its name implies, its downfall comes when attempting to optimize in one area. The costs saved may be inadvertently shifted to another part of the supply chain within the firm or to a vendor.

Kaizen Costing

The term “kaizen costing” is actually somewhat misleading. Kaizen is more of a refinement tool to ensure efficiency in production. Once a product has been in production a certain amount of time, increases in capability and decreases in price are normally expected by the consumer. This can be illustrated with digital watches, hand held calculators and personal computers. First generation prototypes were very expensive and were not very functional. For example, watches simply offered time and date, yet today watches offer multiple time zones, multiple alarms, stop watches, compass heading, altimeter, barometer, ambient air temperature, heart rate, etc., for a significantly lower price. The process of increasing performance and decreasing price is known as kaizen costing (Williamson, 1997).

Supply Chain Costing

Essentially, supply chain costing is activity based costing on a broader level across the entire supply chain. LaLonde and Pohlen (1996) identify the six steps utilized when employing supply chain costing:

1. *Analyzing Supply Chain Processes*
2. *Breaking Processes Down Into Activities*
3. *Identifying the Resources Required to Perform an Activity*
4. *Costing the Activities*
5. *Tracing Activity Costs to Supply Chain Outputs*
6. *Analysis and Simulation*

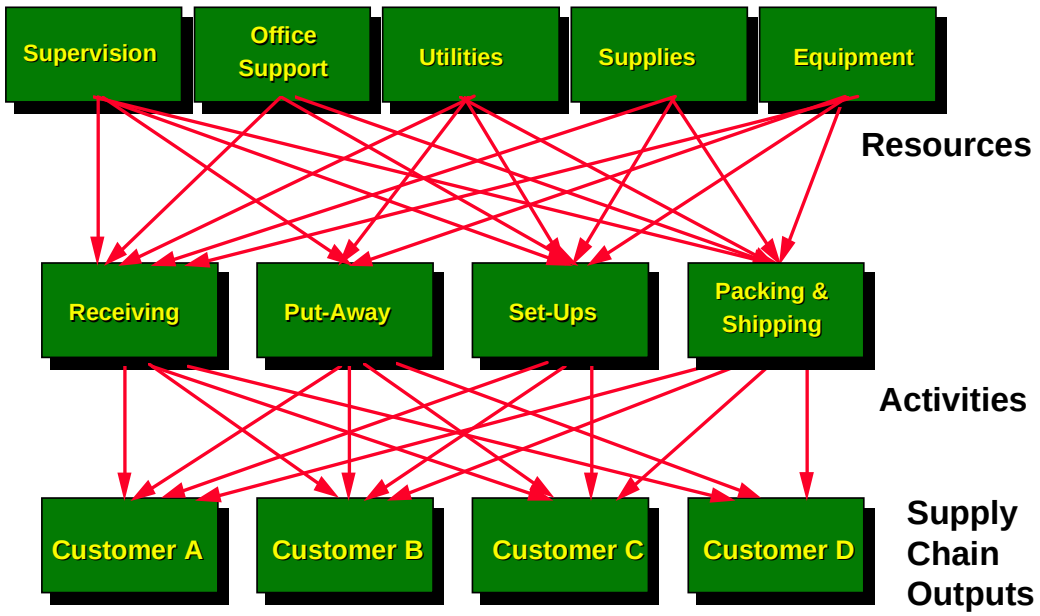

Figure 2. Assignment of Resource Costs to Activities and Supply Chain Outputs (LaLonde & Pohlen, 1996).

Supply chain costing attempts to allocate each cost back to a process or output just like activity based costing. This allows a manager to truly understand what drives cost and, more importantly, how that specific cost can be manipulated. This also opens a managers eyes to the entire supply chain perspective. For instance, if a manager wants to save shipping costs,

he or she can begin shipping Freight On Board (FOB) Origin versus FOB Destination. In a limited sense, the customer has now become responsible for the shipping costs. In reality however, the costs have simply been shifted to another supply chain partner. When viewed from a comprehensive perspective, the overall cost of the supply chain has remained the same.

Firms who have strategic partners or are developing alliances in an attempt to effect a more efficient supply chain can certainly benefit from supply chain costing.

Target Costing

Ellram (1999) defines Target Costing with a simple formula:

Target Cost = Estimated Selling Price – Desired Profit

She points out that estimated selling price and target price are the same thing. This is really a method to ascertain what the market will bear. In essence, the idea is to reverse engineer an appropriate selling price, factor in the desired profit and determine if the resultant target cost is achievable in the current market environment.

The benefit to target costing is the ability to know if a product will generate the desired profit before production begins and resources are committed.

Throughput Accounting

Mena, Whicker, Templar and Bernon (2002), describe throughput

accounting as a derivation of the Theory of Constraints (TOC). TOC fundamentally espouses the notion that any system has at least one constraint that keeps it from maximizing its efficiency or achieving its primary goal (Mena et al, 2002). When the supply chain is viewed through this mechanism, the idea is to focus on the constraints that prevent the end goal, whether that is to penetrate new markets, increase revenue, decrease cost or produce more product.

Throughput accounting intends to assign only direct materials to the product being produced and while this may be appropriate for a short term decision where fixed costs don't play a major role, the failure of this method is its limited focus on the primary constraint being controlled (Mena et al, 2002). As a result, it fails to address overhead and indirect costs and is not an efficient method from a broader perspective.

Total Cost of Ownership

Total Cost of Ownership (TCO) is another approach to measuring costs. Cokins (2001) advocates TCO and points out that the price on the bottom of a vendor's invoice does not represent the entire cost of purchasing an item. There are also costs associated with placing the order, receiving, inspecting, warehousing, late delivery, warranty work and customer returns (Ellram, 1994). All these costs comprise the total cost of ownership. Ellram further distilled TCO down to two models: standard and specific. The standard TCO model is usually supported by a computer or has been

established in writing. It's designed to be used for many types of purchases and can be used on a recurring basis. The specific TCO model is created for a distinct transaction or item (Ellram, 1994). From a DoD perspective, a standard TCO model might be used when purchasing office furniture or office supplies. This type of purchase is relatively straightforward, the items are usually similar and the cost drivers that affect the purchase don't change a great deal from purchase to purchase. Therefore, the standard TCO model can be used again and again. DoD might use a unique TCO model when purchasing a major weapon system such as the Joint Strike Fighter (JSF).

Ellram (1994) also addresses the implications and barriers of TCO. While she believes that TCO is a way to improve a firm's understanding of costs, barriers such as the corporate culture, types of resources utilized/purchased, training, and senior leadership buy-in can make the TCO process difficult to execute. The most significant implication was the realization there isn't a standard tactic or implementation for TCO to be effective and successful (Ellram, 1994).

Scholars (Ellram, 1994; Ferrin & Plank 2002) studied TCO models utilized by leading edge companies and also suggest there is not one correct method or generic template that could be utilized across the board for TCO implementation. While a core set of drivers is needed, each firm can add auxiliary drivers as they deem appropriate (Ferrin & Plank 2002). In other words, there might be a need for an amalgam that combines TCO with ABC to obtain a model that fits the specific needs of the using organization. Essentially, each organization or company would utilize the aspects and

drivers applicable to their industry or its particular operations. A company like United Airlines would choose drivers that differ from retail giant Wal-Mart who would choose drivers that are different from a significantly smaller retail operation. So basically, every company will have a different model. Logically, we can infer that the Air Force should have an individual model exclusive of what other firms might utilize. However, the Air Force is very diverse and even an Air Force specific model that might work at the Warner-Robins ALC in Georgia may not work for the Ogden ALC in Utah, based on factors unique to each center's mission. The difficulty lies in the cost driver(s). Ferrin & Plank (2002) suggested thirteen categories of drivers for cost of ownership:

Operations Cost	Quality
Logistics	Technological Advantage
Supplier Reliability & Capability	Maintenance
Inventory Cost	Transaction Cost
Life Cycle	Initial Price
Customer-Related	Opportunity Cost
Miscellaneous	

Each recommended category can be decomposed into separate subsidiary entries. The miscellaneous category, for example, has 32 separate entries, including:

Taxes
Warranty
Disposal Costs
Currency Exchange Rates
Lease Rate Factors
Obsolescence Cost
Supplier Cost Drivers (From Requisition to Receipt)
Technical Support
Environmental Issues

This method appears to be quite in depth and time consuming. It's apparent that a great deal of time and effort would have to be expended in order to identify an appropriate cost model. For instance, the Air Force would need to determine the cost drivers for the various segments, locations and weapons systems the Air Force utilizes.

ACMI

ACMI stands for aircraft, crew, maintenance and insurance. This is a costing method invented by Atlas Air, Inc. (Air Cargo News, 2004). Atlas's core business is to operate dedicated cargo flights for other airlines under ACMI agreements. Under these types of agreements, the lessee, not Atlas, holds out air service to the shipping public and assumes the marketing risk (Comments of Atlas Air, Inc., 2003). In turn, the lessor charges a reduced rate that includes only aircraft, crew, maintenance and insurance. It becomes incumbent upon the lessee to take care of ground handling, landing fees, overfly fees, and in some cases, fuel. If the lessee believes they can find a better price for fuel, they will opt for the dry lease versus the wet lease alternative. The benefits are cheaper costs but more of an administrative burden to coordinate additional functions which will generate multiple invoices.

Part of the appeal of ACMI is a firms ability to enter and compete in markets without a significant outlay of capital resources to purchase aircraft, incur maintenance, training and crew expenses. Or perhaps a firm wants to expand into a possible market segment but wants to determine if it will be

profitable first. In this case, aircraft get be obtained through ACMI agreements for a pre-determined period of time that could serve as a trial phase (Comments of Atlas Air, Inc., 2003).

It all comes down to the customer deciding if they can get a better deal on the supporting costs and whether the additional administrative workload is worth the effort.

Summary

The costing issues and methods found in the literature are introduced in Tables 5 and 6. The primary costing issues discovered in the literature review are listed down the left side of Table 5, while the source articles are listed across the top.

Table 5. Costing Issues and Sources

Costing Issues (Down) Sources (Right)	Rooting Out Supply Chain Costs (Ayers, 2003)	Diagnosing Costing Problems (Atkinson, 1989)	Three Problems That Linger (La Londe, 2003)	Costing The Supply Chain (Mena et al, 2002)	A Global Supply Chain Model with Transfer Pricing and Transportation Cost Allocation (Vidal & Goetschalckx, 2001)	Issues In Supply Chain Costing (LaLonde & Pohlen, 1996)	Indirect Costs of Contracts (Shelton & Brugh, 2002).	Measuring Supply Chain Performance (Beamon, 1999)	Measuring the Cost of Ownership (Carr & Ittner, 1992)
Lack of Clarity	X								
Lack of Credibility of the Costing System		X							
Lack of Accurate Costing Data for Decision Making			X						
Variability	X								
Information Sharing	X								
Absorption Costing				X					
Supply Chain Costing				X					
Transfer Costing					X				
Competition						X			
Cost/Price Reduction						X			
Overhead/Indirect Cost Allocation							X		
Overhead Creep		X							
Selecting Suppliers Based Solely on Price								X	
Target Costing									X

The primary costing methods discovered in the literature review are listed across the top of Table 6, while the costing issues they address are listed down the left side.

Table 6. Costing Issues and Methods

Costing Issues (Down) Costing Methods (Right)	Activity Based Costing	Direct Product Profitability	Efficient Consumer Reporting	Kaizen Costing	Supply Chain Costing	Target Costing	Throughput Accounting	Total Cost of Ownership	Traditional Cost Accounting
Lack of Clarity	X								
Lack of Credibility of the Costing System	X								
Lack of Accurate Costing Data for Decision Making	X								
Variability	X								
Information Sharing				X		X			
Absorption Costing									X
Supply Chain Costing	X				n/a				
Transfer Costing	X								
Competition						X			
Cost/Price Reduction	X								
Overhead/Indirect Cost Allocation	X								
Overhead Creep	X								
Selecting Suppliers Based Solely on Price						X			
Target Costing						n/a			

These two tables provide a starting point to characterize some of what's known in the realm of costing, as well as how certain costing issues are currently being handled. They have also brought to light some gaps in the assumptions or understanding of the researcher. Perhaps the most basic assumption was that the available costing methods are viable solutions to deal with the costing issues or problems, yet what's shown here isn't quite that simplistic. For instance, while these methods were all identified in the literature review, there are several that fail to address any of the fourteen costing issues identified. There are three possible explanations for this

phenomenon; 1.) The literature improperly identified the problems; 2.) The literature improperly identified the solutions; or 3.) The researcher improperly identified the problems or solutions.

Chapter Overview

This chapter discussed the various costing methods and techniques revealed during the literature review. Some of the issues and problems related to these methods are discussed. Clearly, some of the methods emerge as better than others but that determination is dependant upon the end goal. Certain methods focus on a narrow perspective while others are more broad based in nature. A method used to calculate the entire supply chain cost may not be beneficial when attempting to understand how to optimize performance and reduce the price of a single product.

Ultimately, the manager needs to recognize the various methods and techniques available before deciding which one to select for his or her purposes.

III. Methodology

Chapter Two reviewed the relevant literature and developed the hypotheses to guide the study. This chapter describes the methodology that was used to test these hypotheses. First, this chapter will clearly define the problem. Second, it will discuss how data was collected. Lastly, it will look at data analysis.

Problem Statement

The purpose of this study is to discover what costing techniques are currently being utilized by air cargo carriers and why. Possible implications for the Air Force will also be considered. The study seeks to understand differences among competing cost models used in industry. Additionally, it seeks to understand the rationale behind each firm's choice of the cost model currently being utilized.

To address this problem, the following investigative questions, originally developed in Chapter One, will be answered:

- What costing techniques are currently available?
- What are the key issues in transportation service costing?
- What are the transportation service costing issues faced by air cargo carriers?
- How do these firms address those issues?
- Why are these issues addressed that way?
- What is the relevance to the Air Force of these issues and how they're addressed?

Research Paradigm

The literature review discovered gaps in the characterization of the assumptions related to costing methods and the costing issues they are meant to solve. The most basic assumption was that the available costing methods are viable solutions to deal with the costing issues or problems that emerged from the literature review. Certainly, some models addressed more issues than others; however, since several issues were not addressed by the available costing methods, there is an incongruity in the "fit model."

No commercial organization is comparable to the Air Force, however, some commercial organizations could be sufficiently similar to the Air Force that they could offer information addressing the investigative questions. A thorough search was conducted to identify multiple commercial organizations that have business processes similar to certain segments of the Air Force.

Case Study

A case study research approach was originally considered. Case study research refers to the collection of extensively detailed information about a specific participant, program, process or event. Case studies often include reports on the participants themselves as well the environment that surrounds what's being studied. This in depth analysis is normally done over an extended period of time (Yin, 2003). Since the investigator has little control over the events and the questions being put are of the "how" and "why" variety, case study research is generally the preferred method (Yin,

2003). Case study research is seen as an all encompassing method rather than simply a data collection method and may discover more variables than actual data points (Yin 2003). While this may not be desirable from a statistical perspective, it opens up the issue being studied and provides a deeper understanding as well as possible follow on research paths. On the other hand, case study research is also subject to weaknesses such as investigator bias, whether intentional or unintentional (Leedy & Ormrod, 2001).

One of the strengths afforded by utilizing a case study method is flexibility. If the researcher is unsure where the study may lead because little is known about the topic, a case study approach allows the researcher to begin with a broader perspective and ultimately narrow to a razor sharp focus as the study progresses (CSU, 2004). As Leedy & Ormrod indicated, case study analysis can also open the issue being studied to provide a better understanding and this can lead to a more informed decision about exactly what aspect(s) should be studied further.

A significant weakness of the case study method is the perception that researchers sometimes deviate from the systematic procedures (Yin, 2004). This could affect the credibility of the study, and as a result, call into question the findings and inferences made. Personal bias is another consideration since the researcher will be spending an extended period of time dealing with the participant(s). Bias can affect the research, how it's conducted, preparation of data collection instruments and how the data is analyzed (CSU, 2004).

Although the flexibility offered through the case study method would have been helpful to produce a clearer and more thorough understanding of this exploratory effort, the case study method was rejected primarily because this thesis would not be examining the participants over an extended period of time. As a result, two other methods were considered; a phenomenological study and a grounded theory study.

Phenomenological Study

The purpose of a phenomenological study is to use the respondent's viewpoint to understand an experience or phenomena (Leedy & Ormrod, 2001). It attempts to focus on the "lived experience" and comprehend how a participant perceives, describes, judges and makes sense of a phenomenon that they have experienced first hand (Patton, 2002). This method involves lengthy interviews with participants in order to gain a deeper understanding of the phenomena being studied and these interviews normally have the participant doing most of the talking while the researcher does the listening (Leedy & Ormrod, 2001).

Clearly, a major strength of this method is being able to collect first hand knowledge. Each individual can be seen as a filter for information. As a result, each person has the potential to process information differently so when information is heard second hand, third hand or greater, there is an ever increasing possibility that the information loses accuracy. In the end, a researcher can't be certain whether the original experience has been captured or the perception of the second person that passed it on to the third

person. Another strength of this method would be the ability to ask immediate follow-up questions. The individual who has second or third hand information most likely can not answer simple questions because they weren't there to experience the phenomena, consequently, their information is limited to what they've been told, not what they saw, heard or felt.

A weakness of this method would be researcher bias, specifically if the researcher has experienced the phenomena first hand. To mitigate bias, a researcher is supposed to suspend any preconceived notions regarding their experiences, a process known as bracketing, and this is a critical step if the researcher wants to totally understand the participant's perspective (Leedy & Ormrod, 2001).

Since this study contacted respondents who were directly involved with the costing issues surrounding air cargo carriers, this method seemed appropriate, but the grounded theory methodology still deserved a look.

Grounded Theory

The grounded theory study methodology seeks to utilize collected data in order to formulate a theory (Leedy & Ormrod, 2001). In other words, there are no pre-conceived notions or ideas that are trying to be proven or disproved. Instead of relying on the literature review to yield any possible theories or prejudging where the research might go, grounded theory relies on the data collected from the field to establish the premise (Leedy & Ormrod, 2001). Grounded theory is meant to build theory rather than test theory (Patton, 2002). This method also seeks multiple rounds of data

collection and the two fundamental characteristics are “constant comparison of data with emerging categories and theoretical sampling of different groups to maximize similarities and differences of information” (Creswell, 2003).

A strength of grounded theory is undoubtedly the absence of bias going into the study. After all, if a researcher doesn’t have a predetermined theory in his or her mind, there’s a significantly smaller possibility of leaning one way or the other. In this respect, grounded theory allows the researcher to see a wide open playing field and the data is allowed to direct the theory building.

A possible weakness may be the inability of the researcher to draw the appropriate conclusion or build the proper theory based on the data collected.

The fact that this approach required multiple rounds of data collection initially, made this method look less attractive, but since this study seeks to understand, clarify, refine and propose, this method seemed to be somewhat appropriate.

Hybrid Method

The chosen method is a hybrid between a phenomenological study and a grounded theory study. This research required the presentation of first hand experience of the participants. This first hand perspective is extremely beneficial in understanding this topic. In addition, the ability to ask immediate follow-up questions from the person who has the knowledge is vital if the proper conclusions are to be drawn. While the literature

established a possible theoretical context, it did not provide any instances applicable to the particular research and investigative questions. As a result, the grounded theory aspect of being able to derive theory from data collected is considered an enormous strength for this particular thesis topic. This method also provides a great deal of flexibility to "see what the data says" before committing a great deal of time and effort on the wrong aspect of the research. Because of the questions being asked in this study, the combination of these two methods seemed to be the ideal solution.

Methodology / Experimental Design

Firms in the air cargo arena were selected since they could be construed as sufficiently similar to the Air Force is some respects that might enable the study to gather information to address the investigative questions. There are no civilian firms that fly fighter aircraft so it's logical to focus attention around aircraft such as the C-17 Globemaster, C-141 Starlifter and C-5 Galaxy. These are all jet powered, heavy aircraft designed to move cargo over longer distances. Air cargo firms have operations similar to the Air Force's airlift operations with respect to the heavy aircraft, in that the primary mission of both is to transport cargo versus passengers. Commercial air cargo firms won't fly the C-17, C-141 or the C-5, but rather 747's, 727's, MD-11's, DC-9's etc. The KC-10 Extender aircraft is an in-air refueling platform for the military but it can also carry cargo. The commercial firms would fly a near duplicate in the DC-10 aircraft, which is the civilian version.

A search was made of air cargo firms that currently exist and a list was drafted. The list contained firms discovered during the literature review through a variety of public published sources as well as an internet search. The population of interest was comprised of 20 air cargo firms with operations sufficiently similar to the Air Force's airlift operations. The list was then trimmed down to 16 as four firms were removed from the population; two firms for being in chapter 11 bankruptcy proceedings and two firms for having been acquired by other air cargo firms. The researcher attempted to contact all 16 firms that remained on the list. For those firms that responded, a telephone interview was administered to strategic key participants. The strategic key participants were chosen because of their position and how it directly related to the costing function. The interviews were conducted through exploratory, open-ended questions. The identities of the firms and individuals contacted will remain anonymous per Protocol 04-14-E as approved by the Human Subject Review Board. As such, data that would identify the subject, his/her company or product offerings would not add value to the study, and its exclusion will not impede the analysis.

The results of contacting firms on the list breakout as follows:

- 1 firm said to “call back” at a specific date and time and then didn’t answer (later discovered to be in Bankruptcy proceedings)
- 1 firm was in Chapter 11 Bankruptcy proceedings
- 2 firms merged and were “too busy” with merger related issues to respond
- 4 firms claimed to have no allocations due to using “ACMI” (to be discussed later)
- 1 firm turned out to be a subsidiary of the firm in Chapter 11
- 2 firms had been acquired by other air cargo firms
- 2 firms were left messages but never returned the call
- 2 firms never answered
- 3 firms refused to participate
- 2 firms responded for a 10% response rate

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20 – Total Firms

Participants were initially asked to:

(See Appendix B for Data Collection Instrument)

1. Identify the five most important costs for their respective firms. They were then asked to rank order these five costs. Each cost was then examined more closely.

2. The fundamental follow up question was; “What are the criteria for making this (cost) important?” The objective was to understand the “why”

behind the specific cost being identified as important. Was it the highest dollar value, a hard to get item, an item critical to operations, etc.

3. The next question asked was; “How is this cost assigned or allocated?” The aim was to comprehend how the specific cost is tracked, whether the cost is traced back to a specific activity or function, included in overhead, seen as a variable cost, etc.

4. As a logical follow-on, the next question was; “How are the cost elements assigned to individual services and transactions? Clearly, there is a cost to fly a package from Denver to Atlanta, but that total cost isn’t charged to the customer because it would be cost prohibitive. Somehow, the cost is shared among all customers who have packages or cargo on board the aircraft. The purpose of this question was to ascertain how that happens.

5. Subsequently, the participants were asked; “What is the result of following this method or utilizing this technique?” The desired outcome was to determine what is achieved or what is the yield to the firm, in other words, to find out “why” they were using this method or technique.

6. Finally, the participants were asked to provide a weighting of the five cost elements so the disparity between rankings could be discerned.

Data Sources / Format

The data sources are the literature review and interview responses. Follow up interview and emails were utilized to yield additional information but were primarily for clarification purposes.

Data Analysis

All data will be carefully reviewed. Initially, common threads were sought. There was an expectation that a similar method or technique would emerge as predominant as well as being successful, but that was not the case. Similarities and differences were further explored in an attempt to gain additional understanding. Then a determination was made as to whether a model worked and why. Lastly, possible implications for the Air Force were explored.

Data analysis is not complete until trust and confidence are addressed. Table 7 was adapted from Lincoln & Guba by Isaac and Michael (1997) and takes a look at the trust and confidence issues.

Table 7. Criteria for Establishing Trust and Confidence in Research Results
Lincoln & Guba as adapted by Isaac & Michael (1997)

Conventional Research	Naturalistic Research
Internal Validity – Did variations in the independent variable produce a change in the dependent variable?	**Credibility** – Will the methodology and its conduct produce findings that are believable and convincing?
External Validity – Can the results of this investigation be generalized to other settings?	**Transferabilit**y – To what other contextually similar settings can these findings be applied?
Reliability – Are the results consistent, repeatable, and predictable from one study to another?	**Dependability** – Within reasonable limits, are the findings consistent with other similar studies?
Objectivity – Are the events under study public and observable so as to allow agreement among investigators?	**Confirmability** – Are both the process and the product of the data collection and analysis auditable by an outside party?

Criteria for Establishing Trust and Confidence in Research Results

Each element will be addressed individually to ensure nothing is inadvertently overlooked.

Internal Validity – The researcher remained cognizant of potential biases and be aware of other explanations for the findings.

External Validity – That was not the intent of this study since it was meant to be descriptive rather than prescriptive, but it is logical to conclude that other air cargo firms would respond in a similar manner and it's hopeful that there might be some Air Force generalizability.

Reliability – Again, it is logical to conclude that other air cargo firms would respond in a similar manner.

Objectivity – The identities of the respondents and their firms are anonymous and therefore, not public. However, fellow investigators on this study could easily reach the same conclusion. Interviews were audio taped and data collections forms were utilized.

Credibility – The methodology asked open ended questions during a semi-structured interview to enable a free flow of information and ideas. As a result, if another researcher asked the same questions in the same manner, he or she should obtain similar results.

Transferability – The intent of this study was to be descriptive rather than prescriptive, however, there may some implications for the Air Force.

Dependability – The literature review yielded no similar studies, nevertheless, it is reasonable to suppose a similar study, or a follow-on study, conducted in the future may produce comparable results.

Confirmability – The process is certainly auditable by an outside party, but since the identities of the respondents and their firms are anonymous, the product of the data collection (otherwise known as the data) is not. However, the audio tapes and the data collection forms are still on file with the researcher.

Overview

This chapter clearly defined the problem, described the methodology that was used to test these hypotheses, discussed how the data was collected and finally, looked at data analysis to include trust and confidence. Chapter Four will present the data and summarize the raw results. It will then discuss an analysis and interpretation of the data.

IV. Analysis

Chapter Three described the methodology that was used to test the hypotheses set forth in Chapter Two. This chapter will present the data and summarize the raw results. It will then discuss an analysis and interpretation of the data.

Findings

The literature review revealed the following costing issues (see Table 8 below) along with the method mostly likely to solve or address the issue. The methods were also discussed during the literature review phase in Chapter Two.

Table 8. Issues and Methods From the Literature

Issues	Method
Lack of Clarity	Activity Based Costing (ABC)
Lack of Credibility of the Costing System	ABC
Lack of Accurate Costing Data for Decision Making	ABC
Variability	ABC
Information Sharing	Kaizen Costing & Target Costing
Absorption Costing	Traditional Cost Accounting
Supply Chain Costing	ABC
Transfer Costing	ABC
Competition	Target Costing
Cost/Price Reduction	ABC
Overhead/Indirect Cost Allocation	ABC
Overhead Creep	ABC
Selecting Suppliers Based Solely on Price	Target Costing
Target Costing	

Air Force

The Air Force has identified certain costs as important by virtue of including them in their CPFH calculation. The factors are listed in Table 9 below.

Table 9. Air Force Cost Per Flying Hour Factors

Issues	Air Force	Method
Cost Per Flying Hour: *comprised of AVFuel, SSD, GSD & DLRs*	Major Issue--used to develop realistic estimate	CPFH Model
Aviation Fuel (AVFuel)	Used to develop realistic estimate	CPFH Factor
Consumable Supplies: *comprised of SSD & GSD*		
System Support Division (SSD)	Used to develop realistic estimate	CPFH Factor
General Support Division (GSD)	Used to develop realistic estimate	CPFH Factor
Depot Level Reparables (DLRs)	Used to develop realistic estimate	CPFH Factor
Maintenance	Significant expenditure	Included as logistical cost factor to calculate total flying hour cost
Crew Costs / Payroll	Fixed Cost - Utilized for reimbursement outside USAF	Dependent upon crew members rank and time in service

The primary number that serves as a baseline in the Air Force is Cost Per Flying Hour (CPFH). Since the Air Force flies multiple airframes, CPFH is calculated by aircraft type, and the Air Force utilizes four factors to calculate a baseline rate using the most recent numbers for obligations and flying hours. The four factors are listed below:

1. ***System Support Division*** (SSD) – disposable aircraft parts, antennas, lights, wiring, windshields, etc.
2. ***General Support Division*** (GSD) – other expendable items which include common bench stock items, administrative supplies, tools, etc.
3. ***Depot Level Reparables*** (DLRs) – aircraft parts removed by wing maintenance personnel and sent to depots for repair.
4. ***Aviation Fuel*** (AVFuel) –Fuel used during flight, which typically includes JP-4, JP-8, off-station fuel and in-flight refueling. The AVFuel factor is expressed in gallons per hour, which is converted into a dollar per hour factor based on DoD established prices for each fuel type.

(Rose, 1997)

Numbers one and two fall under a broader category called Consumable Supplies, so at times, CPFH may be referred to as having three categories instead of four. Contractor Logistics Support and Crew costs are added to calculate a reimbursable CPFH.

Results

Interviews were conducted via the telephone and questions were asked in the same order for all respondents. The interview method using the phenomenological approach was invaluable as first hand experience was collected and immediate follow-up clarification questions could be asked.

Firm A

The first interview question asked of respondent A was, **"*What are the five most important costs for this firm?*"** This was immediately followed up with, **"*How would you rank order these five items?*"** The costs and respective rankings are listed in Table 10. The responses for Air Cargo Firm A are below.

Table 10. Firm A Ranking

Importance	Cost Category
1	Fuel
2	Maintenance - Heavy
3	Flight Ops - Crew Costs
4	Insurance
5	Depreciation

Each item was then taken individually and given additional attention. There were five additional questions asked regarding each item. The questions and responses are below. Responses are summarized.

1. Fuel

What are the criteria for making this important?

Fuel is the most expensive and volatile operating cost.

How is this cost assigned or allocated?

The cost is allocated by pegging[*] the fuel price in contracts. The goal is to limit as much exposure as possible.

[*]Fuel prices are expected to rise and fall, but a starting point must be established when the contract is written. As a result, fuel is pegged at a particular price that is agreed to by both parties.

How are the cost elements assigned to individual services and transactions?

The cost is then reconciled at the end of a certain period and price is adjusted accordingly.

What is the result of following this method or utilizing this technique?

Pegging allows the firm to limit their exposure on the volatility of fuel prices.

How would you characterize the success of utilizing this technique?

This method is very successful as far as limiting exposure, but the firm essentially pays a fixed price. The firm is limited on the upside exposure, but they don't benefit when fuel prices are down. When fuel prices are down, they are paying above market rate for fuel. (Although this firm doesn't, many large airlines hedge their fuel exposure by trading barrels of oil on the futures market.)

2. Maintenance – Heavy

What are the criteria for making this important?

Maintenance is the second most expensive operating cost.

How is this cost assigned or allocated?

Maintenance is a variable cost in the firm's costing model.

How are the cost elements assigned to individual services and transactions?

The cost are broken down into a per flight hour rate by adding up all the maintenance expenses and dividing that figure by the total number of flight hours. This generates a per flight hour rate based on aircraft type. This is then charged back to the customer based on the utilization of a specific contract.

What is the result of following this method or utilizing this technique?

The intent is to recover all maintenance costs. This difficulty is that since it is a variable cost, recovery of costs is dependent upon utilization. For instance, a "C" check is a type of heavy maintenance check and is good for 5,000 hours or 24 months, which ever comes first. If the aircraft only has 2,000 hours of usage during 24 months, the full cost of the "C" check would not be recovered.

How would you characterize the success of utilizing this technique?

This method could be more effective, because the pricing of maintenance is based on historical costs. It is very difficult to predict the future cost of maintenance. The largest cost within maintenance is engine overhauls. To limit the firm's exposure on engine costs, they have implemented fixed prices on overhauls with many of their vendors. The heavy checks are the big drivers in maintenance costs and they vary significantly from check to check. Allocating against aircraft types also makes it easier to identify trends.

3. Flight Operations (Crew Costs)

What are the criteria for making this important?

Highest labor function of all cost and includes pilots, first officers and flight engineers.

How is this cost assigned or allocated?

Costs are allocated as fixed costs in the costing model.

How are the cost elements assigned to individual services and transactions?

The costs are assigned based on the number of crews required with the given utilization. The costing number is based on the average salary of the crews.

What is the result of following this method or utilizing this technique?

In the aggregate, the cost of the crews is recovered. On individual segments, depending on the seniority of the crews, there is a possibility of coming out ahead or behind. A contingency is built in by multiplying the number of required crews by a factor. If may not always be needed, but in the aggregate, it balances out.

How would you characterize the success of utilizing this technique?

This method is very successful most of the time. However, if there are delays for any given reason, the crew costs are the first to suffer. Since crew costs are in the fixed portion of the costing model, crews costs are a function of utilization. There is a direct benefit with higher utilization of crews.

4. Insurance

What are the criteria for making this important?

Insurance costs are important because it is a cost that can be compared directly with competitors.

How is this cost assigned or allocated?

Insurance costs are allocated by taking the total amount of insurance premiums and applying a given percentage to a specific aircraft type.

How are the cost elements assigned to individual services and transactions?

Insurance is in the fixed portion of the costing model. Premiums are paid based on aircraft values, not flight activity. Therefore there is a greater benefit with higher utilization.

What is the result of following this method or utilizing this technique?

Insurance costs are covered if a given utilization is reached.

How would you characterize the success of utilizing this technique?

This method is successful if utilization assumptions are reached. Since it is based on utilization, there is exposure on both sides, positive and negative.

5. Depreciation

What are the criteria for making this important?

This is a significant cost, because it is based on the book values of aircraft. This is, however, not a cash cost.

How is this cost assigned or allocated?

Like insurance, depreciation is allocated by taking the total amount of depreciation, then applying a given percentage to a specific aircraft type.

How are the cost elements assigned to individual services and transactions?

Depreciation is also a fixed cost in the costing model, so there is a benefit from high utilization.

What is the result of following this method or utilizing this technique?

Depreciation costs are recovered if a given utilization is reached.

How would you characterize the success of utilizing this technique?

Like insurance, the method is successful if utilization assumptions are reached.

Respondents were then asked to weight their five most important costs with respect to how much time and/or attention was routinely dedicated to the cost. The weighting was on a scale from one to ten with ten being the most time and/or attention and one being the least. The results are listed in Table 11.

Table 11. Firm A Weighting

Importance	Cost Category	Weighting
1	Fuel	10 out of 10
2	Maintenance - Heavy	8 out of 10
3	Flight Ops - Crew Costs	7 out of 10
4	Insurance	3 out of 10
5	Depreciation	5 out of 10

Firm B

The first interview question asked of respondent B was, **"*What are the five most important costs for this firm?*"** This was immediately followed up with, **"*How would you rank order these five items?*"** The costs and respective rankings are listed in Table 12. The responses for Air Cargo Firm B are below.

Table 12. Firm B Ranking

Importance	Cost Category
1	Maintenance - Heavy
2	Payroll
3	Maintenance - Routine
4	Servicing Costs
5	Fuel

Each item was then taken individually and given additional attention. There were five additional questions asked regarding each item. The questions and responses are below.

1. Maintenance - Heavy

What are the criteria for making this important?

Heavy maintenance was chosen due to its high dollar value. Heavy maintenance is a significant expenditure.

How is this cost assigned or allocated?

The cost is assigned by aircraft tail number or by specific engine number.

How are the cost elements assigned to individual services and transactions?

The cost is allocated to individual services and transactions according to the contract that aircraft are flying for, or by the number of flight hours utilized.

What is the result of following this method or utilizing this technique?

This method helps to understand the profitability issue more clearly.

How would you characterize the success of utilizing this technique?

This method is very successful with respect to tracking usage against scheduled heavy maintenance checks because the costs are directly attributable to an indicated aircraft tail number.

2. Payroll

What are the criteria for making this important?

Payroll is also a high dollar value cost and it's extremely important from a productivity standpoint. Pilots get paid whether they sit in the office or the cockpit so it's imperative that a level of efficiency is achieved that, in turn, ensures productivity.

How is this cost assigned or allocated?

Payroll allocation is handled in a two-fold manner. First, aircrew salaries are allocated by the number of crews required per contract. Maintenance and technical services personnel are also allocated against specific contracts. Secondly, support personnel (finance, human resources, information technology and executive committee members) are assigned or allocated across the aircraft flown.

How are the cost elements assigned to individual services and transactions?

The aircrew, maintenance and technical services personnel are charged based on the utilization of a specific contract. The support personnel payroll is split by stations based on a percentage. Finance speaks to the station managers at least once a quarter to determine the applicable percentages. This percentage is either the number of flights processed or the percentage of aircraft assigned to that station that support a specific contract, whichever turns out to be a more accurate split.

What is the result of following this method or utilizing this technique?

The technique aids in the understanding of profitability, whether that is the profitability of a specific contract or an aircraft type. For instance, it might shed light on a different way to schedule crews or routes that is more effective or productive.

How would you characterize the success of utilizing this technique?

This method could be more effective, because average salary numbers are utilized for calculations, yet crews have a wide range of possible salaries. If a junior aircrew flies, the profit is higher and if a more expensive senior crew flies, the profit drops.

3. Maintenance - Routine

What are the criteria for making this important?

This cost's variability, expense and risk caused it's placement as number three. Routine maintenance on a forty year old aircraft could yield unexpected and expensive repairs.

How is this cost assigned or allocated?

Costs are allocated by aircraft tail number.

How are the cost elements assigned to individual services and transactions?

The costs are assigned based on the specific contract that the tail number flew against.

What is the result of following this method or utilizing this technique?

Once again, the result focuses on profitability. It illustrates the overall maintenance expense associated with an aircraft by plainly showing the number of events and the exact dollars associated with a particular aircraft. This further helps make decisions about whether to keep an aircraft or turn it back in if it's leased.

How would you characterize the success of utilizing this technique?

This method is successful and allows a better understanding of an aircrafts history so decisions about its future can be made more quickly.

4. Servicing Costs

What are the criteria for making this important?

Variability is one of the bigger reasons why this cost is important. Surprises often crop up in this area and they are hard to predict and track. Late invoices are also an important issue in this area.

How is this cost assigned or allocated?

These costs are allocated by specific contract.

How are the cost elements assigned to individual services and transactions?

Again, these costs are assigned by to the customer through specific contracts.

What is the result of following this method or utilizing this technique?

This method helped get a handle on total costs.

How would you characterize the success of utilizing this technique?

This method is mostly successful but there are still going to be surprises which can't be predicted and will continue to be difficult to track. Late invoices still arrive from an overseas servicing point, sometimes four or five months after the fact, which puts the expense in a different reporting period. Assigning this cost back to a specific contract makes it easier to get reimbursed, even if the invoice is late.

5. Fuel

What are the criteria for making this important?

This is a significant cost because it is the largest single expense. Despite being the largest expense, it was listed as number five because it is the easiest to track precisely.

How is this cost assigned or allocated?

This cost is allocated at the route level. There is tracking software that can determine how much fuel should be used by flight, how much was uplifted and does this in a very timely manner. This is then charged back to the customer or a specific contract.

How are the cost elements assigned to individual services and transactions?

Charged back to the customer or a specific contract.

What is the result of following this method or utilizing this technique?

It provides a true cost per customer or per a contract, by route and by aircraft. Furthermore, this aides with future pricing.

How would you characterize the success of utilizing this technique?

Very successful. There are never any surprises with fuel.

Respondents were then asked to weight their five most important costs with respect to how much time and/or attention was routinely dedicated to the cost. The weighting was on a scale from one to ten with ten being the most time and/or attention and one being the least. The results are below in Table 13.

Table 13. Firm B Weighting

Importance	Cost Category	Weighting
1	Maintenance - Heavy	8 out of 10
2	Payroll	5 out of 10
3	Maintenance - Routine	7 out of 10
4	Servicing Costs	6 out of 10
5	Fuel	3 out of 10

Summary

At first glance, there appear to be some similarities and some differences in the responses. The data analysis section will explore these further as well as address unanticipated findings and confounds to inference. A summary of issues is listed in Table 14.

Table 14. Respondent's Cost Issues & Methods

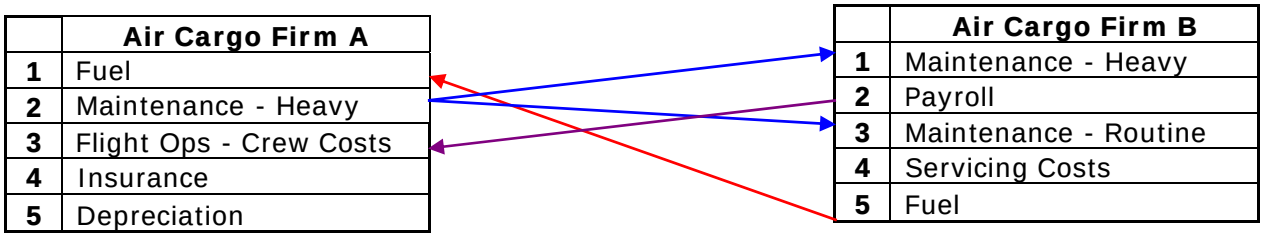
Issues	Respondents	Method
Cost Per Flying Hour: *comprised of AVFuel, SSD, GSD & DLRs*	Used as benchmark for comparison	Split by fuel and maintenance
Aviation Fuel (AVFuel)	One of the top five issues identified	Tracking software & pegging price to limit exposure
Depot Level Reparables (DLRs)	Included with broader maintenance category	Dependent on minimum aircraft utilization rate
Maintenance	Major Issue	Dependent on minimum aircraft utilization rate
Insurance	Important as comparison to competitors	Dependent on minimum aircraft utilization rate
Depreciation	Based on book values of aircraft	Dependent on minimum aircraft utilization rate
Crew Costs / Payroll	Major Issue	Fixed cost dependent on utilization rate & allocating against contracts
Servicing Costs	Major Issue due to variability	Allocated against specific contract

Data Analysis

Both firms shared three cost categories in their top five most important costs. While it may be safe to assume the majority of firms in the air cargo arena share many of the same cost types, it's interesting to note

how their viewed by the respective firm. Figure 3 shows the divergent viewpoints, with fuel having the greatest deviation.

Figure 3. Top Five Most Important Costs Comparison



Fuel is listed by both firms as one of their five most important costs. Firm A listed it as number one while firm B listed it as number five. A closer look reveals that firm A listed it as it's most expensive and volatile operating cost while firm B merely listed is as it's most expensive cost. Firm B seems to have removed the volatility from this cost and they boldly stated that this cost is considered to be low risk and does not include many surprises. This was attributed to the tracking software they utilized that accurately calculated fuel required and then compared that to actual fuel uplifted in a timely manner. In addition, if fuel prices rise above the pegged price stated in the contract, the difference is charged to the customer. If fuel prices drop below the pegged price, the customer is reimbursed.

Maintenance is the next issue listed by both firms, however firm B split maintenance into heavy and routine with heavy listed as their number one important cost. Heavy maintenance includes engine overhauls which are

very costly. Firm A wisely outsourced this function and negotiated fixed prices with their vendors. During the interview, firm A also indicated that post September 11th, as demand dropped dramatically, many aircraft across the industry were parked. This resulted in excess engine availability on the market. Firm A took advantage of this opportunity and leased many of these engines at an hourly rate. The outcome was a significant savings because it was more cost effective to run the new engines at the lower economical rate than performing heavy maintenance checks on certain airframes. Overall, this demonstrates a flexibility of firm A to quickly respond to changes in the market or industry.

The last issue shared by both dealt with compensation. Firm A listed crew costs as number three while firm B listed the broader category of payroll as number two. Both firms, however, focused on crew costs or the cost of pilots, first officers and flight engineers and the largest expenditures within this category. Both seem to have addressed the issue satisfactorily but feel there is room for improvement. The main problem is the inability to get exact calculations when estimating costs due to the wide range of seniority and associated pay scales of crew members. This means average crew costs have to be used and the actual numbers will almost always be higher or lower, but rarely on target.

Figure 15 adds the weightings these firms gave to the three shared cost categories. The ranks and the weightings are within one or two of each other with the glaring exception of fuel which is highlighted.

Table 15. Cost Element Ranking and Weighting

Firm A		Cost	Firm B	
Weight	Rank	Element	Rank	Weight
10	1	Fuel	5	3
8	2	Maintenance	1 & 3	8 & 7
7	3	Payroll/Crew Costs	2	5

The analysis would conclude that although this specific cost is common to both firms, how it's handled, allocated or tracked plays a significant role is how it is viewed by the firm. In other words, the better a cost can be controlled, the less of a problem it presents. If some or all of the variability is taken out of the equation, it becomes easier to predict the behavior of that cost and, ultimately, estimate it far more accurately.

The analysis may also indicate that since firm A didn't list servicing costs in their top five, they may have discovered and implemented a method for controlling this cost. Again, if it's controlled effectively, it may not require as much attention and, as a result, moves down the priority list so management has the opportunity to focus on the remaining costs that don't enjoy a firm level of control.

Insurance and depreciation are the remaining costs identified in this study. To a great extent, these costs can be seen as predetermined and non-variable. Over time insurance may vary but the point is that the firm can't actually do anything to significantly change these two costs. Depreciation is dictated by accounting standards and tax code and can't be

altered to make the numbers come out a different way. The implication here is that if all other costs are optimized efficiently, a firm can't look to insurance and depreciation as a way to increase efficiency or generate a greater return. Consequently, firm A strives to ensure these costs are covered up front. They've determined that maintaining a certain utilization rate will ensure the costs are covered. As long as an aircraft is flying, it generates revenue. However, unlike fuel, whether an aircraft is flying or parked, insurance and depreciation are still an issue.

An unanticipated finding was the use of ACMI by four of the firms contacted. ACMI stands for Aircraft, Crew, Maintenance and Insurance. ACMI was never found in the literature review, nor did it emerge during the interviews conducted with firms A and B. It was explained by a firm that chose not to respond that when a customer wants to charter an aircraft or simply move cargo, they are charged ACMI. As a result, the firms claim there are no indirect costs to allocate or trace. This appears to be an industry-specific, practitioner-developed method that assigns intermediate cost categories to the four listed as components of ACMI. Even if broad assumptions are made, such as every single expense related to an aircraft (fuel, depreciation, servicing costs) are included under Aircraft and all expenses related to maintenance (parts, labor, facilities at the maintenance station) are included under Maintenance, that still doesn't account for the salary of the CEO or the information technology worker or the customer service representative that answers the phone. It is the researcher's belief that ACMI, while utilized to some extent to control costing, was exploited as

a reason not to participate in the study. This allowed a potential respondent to opt out without refusing to cooperate, but rather, as an excuse that they had no control over.

Overall Comparison

An overall comparison was made between the Air Force, the Literature review and the commercial air cargo firms. The results were compiled into Table 16 located on the following page. The shaded areas illustrate known gaps in and amongst the three domains identified which are the; Air Force, Literature (theory) and data collected from the Respondents. The table also identifies some differences and similarities among the three domains. These will be addressed below the Table.

Table 16. Summary of Overall Comparison

Issues	Air Force	Method	Literature	Method	Respondents	Method
Cost Per Flying Hour: *comprised of AVFuel, SSD, GSD & DLRs*	Major Issue--used to develop realistic estimate	CPFH Model			Used as benchmark for comparison	Split by fuel and maintenance
Aviation Fuel (AVFuel)	Used to develop realistic estimate	CPFH Factor			One of the top five issues identified	Tracking software & pegging price to limit exposure
Consumable Supplies: *comprised of SSD & GSD*	Used to develop realistic estimate	CPFH Factor				
System Support Division (SSD)	Used to develop realistic estimate	CPFH Factor				
General Support Division (GSD)	Used to develop realistic estimate	CPFH Factor				
Depot Level Reparables (DLRs)	Used to develop realistic estimate	CPFH Factor			Included with broader maintenance category	Dependent on minimum aircraft utilization rate
Maintenance	Significant expenditure	Included as logistical cost factor to calculate total flying hour cost			Major Issue	Dependent on minimum aircraft utilization rate
Lack of Clarity			Identified	Activity Based Costing (ABC)		
Lack of Credibility of the Costing System			Identified	ABC		
Lack of Accurate Costing Data for Decision Making			Identified	ABC		
Variability			Identified	ABC		
Information Sharing			Identified	Kaizen Costing & Target Costing		
Absorption Costing			Identified	Traditional Cost Accounting		
Supply Chain Costing			Identified	ABC		
Transfer Costing			Identified	ABC		
Competition			Identified	Target Costing		
Cost/Price Reduction			Identified	ABC		
Overhead/Indirect Cost Allocation			Identified	ABC		
Overhead Creep			Identified	ABC		
Selecting Suppliers Based Solely on Price			Identified	Target Costing		
Target Costing			Identified			
Insurance	Government is a self insurer	Not a factor			Important as comparison to competitors	Dependent on minimum aircraft utilization rate
Depreciation	Government doesn't pay taxes so depreciation is irrelevant	Not a factor			Based on book values of aircraft	Dependent on minimum aircraft utilization rate
Crew Costs / Payroll	Fixed Cost	Dependent upon crew members rank and time in service			Major Issue	Fixed cost dependent on utilization rate & allocating against contracts
Servicing Costs					Major Issue due to variability	Allocated against specific contract

For the sake of simplicity, the three domains will be Air Force (USAF), Literature (Theory) and data collected from respondents (Civilian).

Similarities

Theory – USAF

Unfortunately, the Literature review didn't really do much with regards to identifying cost issues and methods for the Air Force. Not one of the issues or methods were found in or used by the Air Force. In essence, there was no overlap between the two domains.

Theory – Civilian

Although the Literature review dealt primarily with civilian business entities, there was no overlap here either. While being interviewed, the respondents never mentioned any of the cost issues or methods identified by the Literature as being pertinent.

USAF – Civilian

Overlap was discovered in a number of areas. First was CPFH where both utilized it as a benchmark for comparison. The respondents per hour figures, however, weren't quite the same. For instance, the Air Force included the four factors listed previously; AVFuel, SSD, GSD and DLRs. When calculating reimbursement rates, the Air Force also adds in Contractor Logistics Support and crew costs. The respondents, on the other hand, used a per flying hour factor for fuel and another for maintenance.

Crew costs were also an area where overlap was found. Both realize it's a fixed cost but there's a much greater impact to the respondents who must ensure crew costs as well as the broader category of payroll, is covered by revenue generated from operations. The Air Force doesn't worry about this since a different pot of money provides pay and allowances for its members.

Lastly, maintenance was a shared issue. Maintenance is a significant cost for the Air Force and for the respondents. Both are attempting to control their respective costs and streamline efficiencies. Both are also facing rising maintenance costs associated with aging aircraft in the fleet.

Differences

Theory – USAF

The differences demonstrated here were glaring. Not one item matched up or overlapped. It's clear that the Air Force is not representative of firms or organizations found in the Literature review.

Theory – Civilian

While the researcher anticipated there would be more similarities between the Literature and the respondents, he was surprised to see none. There is a large gap between the issues and methods identified in the Literature and what the respondents firms were experiencing.

USAF – Civilian

The two differences that stand out are Insurance and Depreciation. While these were important issues for the respondents, they are irrelevant for the Air Force. The federal government (to include the Air Force) is a self-insurer so this is not a cost issue for the Air Force. Depreciation is a function of the accounting standards and the tax code. Since the Air Force doesn't pay taxes, depreciation is a moot point.

From the chart, it may appear there are other differences such as servicing costs, SSD and GSD but while the Air Force has servicing costs it most likely rolls them up in the broader category of Consumable Supplies.

Chapter Overview

Chapter Four presented the data collected from the field and analyzed that data. This chapter provided insight into the ways air cargo firms view their important costs and how they account for or allocate them. Plainly, there are differing opinions on how certain costs should be viewed or handled. Chapter Five will draw conclusions, seek implications for the Air Force and make recommendations for future research.

V. Discussion, Conclusions and Recommendations

Chapter Four presented the data collected from the field and analyzed that data. It also provided insight into the ways air cargo firms view their important costs and how they account for or allocate them. This chapter will draw conclusions, seek implications for the Air Force and make recommendations for future research as well as answer the research and investigative questions.

Research Questions

1. What costing techniques are currently being utilized by air cargo carriers and why?

It turned out that none of the costing techniques found in the Literature were identified by the respondents. They prefer a 'per flying hour' technique to get a better understanding of how costs and revenue offset each other. For instance, they utilize a per flying hour to understand fuel and maintenance expenditures.

2. What are the possible implications for the Air Force?

The Air Force currently utilizes a much more comprehensive CPFH cost model to calculate it's cost per flying hour rate, and in turn, utilizes this rate for future budgeting and estimation purposes.

Investigative Questions

1. What costing techniques are currently available?

While the Literature identified ABC, Kaizen Costing, Target Costing, Traditional Cost Accounting, Direct Product Profitability, Efficient Consumer Reporting, Supply Chain Costing, Throughput Account and Total Cost of Ownership, none of these were identified as current techniques utilized by the respondents. The respondents preferred a per flying hour method of allocating costs and the Air Force prefers a comprehensive CPFH model.

2. What are the key issues in transportation service costing?

Clearly it's fuel and maintenance. These two costs were shared by the Air Force and the respondents. Crew costs, servicing costs, insurance and depreciation are issues for the respondents. Crew costs are also important to the Air Force when calculating a reimbursement rate.

3. What are the transportation service costing issues faced by air cargo carriers?

Reaching a minimum utilization rate to ensure enough revenue is generated to cover costs. Again, fuel is a significant issue mainly because of the magnitude of the expenditure as well as the volatility of the price.

4. How do these firms address those issues?

Through the use of a per flying hour breakdown to better understand their costs either by contract or by airframe.

5. Why are these issues addressed that way?

Firm B sees each contract as a profit center so they want to ensure that profit is being made on every contract. Firm A see every aircraft or airframe type (e.g., 747-400's) as a profit center and when all 747-400 total maintenance costs are divided across total flight hours, they have a fairly

accurate idea if it's time to turn that airframe back in, if it's leased, and obtain something newer or more efficient.

6. What is the relevance to the Air Force of these issues and how they're addressed?

The primary relevance would be the flexibility and speed with which a civilian firm can respond to market changes or opportunities. The Air Force has the added constraint of being restricted by the appropriated fund budgeting process where requests have to be submitted far in advance and this precludes the Air Force from being able to swiftly seize opportunities. For example, post September 11th, demand for charter aircraft (cargo and passenger) dropped dramatically. Aircraft across the industry were parked and this resulted in excess engine availability. Since engines are extremely expensive, Firm A was able to avail itself of the excess in a buyers market and they are still reaping those benefits today. It would be very difficult for the Air Force to come up with a few extra hundred million dollars if an opportunity presented itself.

Conclusions and Recommendations

Managerial Implications

After reviewing Chapter Four, the main conclusion comes from seeing how the firms perceived their respective costs and how those perspectives differed. For instance, fuel received a great deal of attention since both firms

viewed it so differently. While this specific cost is common to all firms that utilize aircraft in the accomplishment of their mission, how the cost is allocated or tracked plays a significant role is how it is viewed by the firm. Firm B ranked it lower and gave it a lower weighting as well. The reasonable conclusion is that Firm B is able to better control this cost, most likely through the use of their tracking software. They indicated that a great deal of time and attention is not required to manage fuel costs and there are rarely surprises in this area. Clearly, the better a cost can be controlled, the less of a variability it presents. Once variability is removed or mitigated, it becomes easier to predict the behavior of that cost more accurately. If the cost can be estimated more accurately, it moves down the priority list and less time/attention is devoted to it.

The fact that Firm A didn't list servicing costs in their top five indicates they may have instituted a method for manipulating and effectively controlling this cost, similar to what Firm B has been able to accomplish with fuel costs. Management will constantly be forced to focus on costs that aren't controlled effectively because they will otherwise add unwanted variability. Stability is always favored over variability when it comes to cost because it allows cost to be estimated more easily and accurately. As a result, firms will evidently prefer a cost that is more direct or at least unit variable. For instance, the longer the flight, the more fuel is burned so although fuel is variable, it is directly related to something that is controllable, in this case, time or distance. The goal then would be to take

all variable and indirect costs and make them more direct or unit variable through allocation methods.

Figure 4 below demonstrates the desired shift to increased controllability. Table 17 on the following page contains cost type definitions to further explain the elements mentioned in Figure 4.

DESIRED COST MOVEMENT

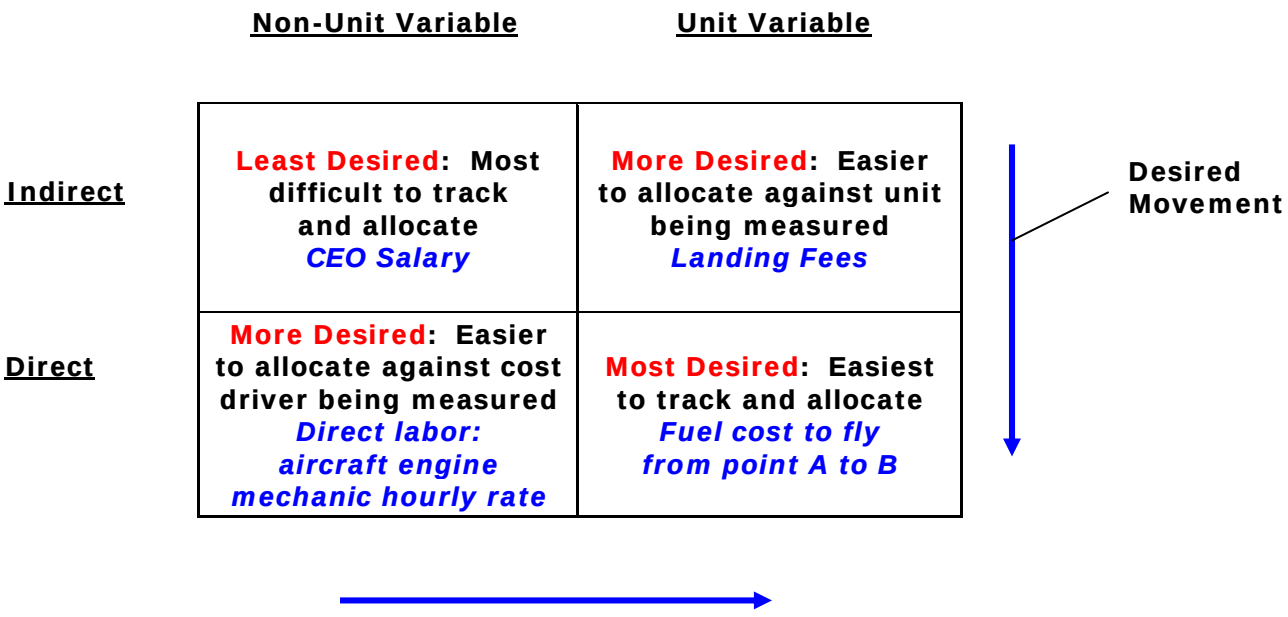


Figure 4. Desired Cost Movement

Table 17. Cost Definitions (Blocher, Chen & Lin, 2002)

Non-unit variable cost	Unit variable cost
Not directly traceable to the specific labor or materials associated with a single unit of goods sold. Unit variable cost can include general overhead.	Directly traceable to the specific labor or materials associated with a single unit of goods sold. Unit variable cost does not include general overhead.
Indirect cost	**Direct Costs**
Incurred for a common or joint purpose and therefore cannot be identified readily and specifically with a particular sponsored project or instructional activity, or any other institutional activity.	Can be identified specifically with a particular sponsored project, an instructional activity, or any other institutional activity, or that can be directly assigned to such activities relatively easily with a high degree of accuracy.

COST DEFINITIONS

As soon as costs are more effectively controlled, management can return its focus to the strategic vision rather than the tactical problems that drain resources and attention away from the bigger picture. It becomes difficult to "grow" the firm when time is spent either reacting to problems or seeking to get control of variables and costs.

Insurance and depreciation were listed by Firm A but not Firm B. This is yet another instance where Firm B may have established a more effective way of controlling these costs despite the fact that to a great extent, these costs can be seen as predetermined and non-variable. Or perhaps Firm B realizes that they can't actually do anything to significantly change these two

costs, so they incorporate them into a cost model and turn their focus elsewhere.

This brings up the remaining two costs; maintenance and compensation (comprised of crew costs for Firm A and the broader category of payroll for Firm B). Since both firms viewed these costs fairly evenly, the resounding conclusion is these two costs still have room for vast improvement. In other words, neither firm has ascertained the ideal method to control the variability inherent to these two costs. Both are large expenditures and directly impact the bottom line. For commercial firms, they can impact profit. For organizations such as the Air Force, it can directly impact mission accomplishment. Although compensation, or pay, is allocated differently in the military, maintenance cost is an area wide open for improvement. A limited amount of appropriated fund dollars are allocated each fiscal year and if those dollars aren't managed efficiently, it could leave the Air Force short of spare parts or mission ready aircraft. In much the same way both air cargo firms were concerned with heavy checks related to maintenance, the Air Force is concerned with it's version called depot maintenance. While aircraft are undergoing this type of in depth maintenance they are unavailable to generate revenue or accomplish the mission. This is unmistakably an area that requires further study.

From a broader standpoint, managers in the Air Force don't need to contemplate how to deal with cost elements like depreciation or insurance. The salaries for pilots, co-pilots, flight engineers, navigators and loadmasters come from a different pot of money and are based on rank and time-in-

service, which the Air Force can't necessarily control. That leaves fuel and maintenance as costs that can be further controlled to realize efficiencies.

Limitations

It's important to note that the air cargo firms that responded shared two characteristics. They shared a common market segment and both enjoyed a flow of senior executives drawn from a certain customer base. This cross flow of executives provided an expertise that afforded a deeper understanding of the market segment.

Future Research

- Determine if the Air Force could benefit from some type of tracking software, similar to Firm B, to manage its fuel costs.
- Study ACMI in greater detail to ascertain if there are any costing efficiencies available for the Air Force when they contract for commercial airlift efforts.
- If a similar topic is studied in the future, a different perspective on the Literature needs to be conceptualized since this Literature review appeared to illustrate more gaps than linkages.
- Focus a study specifically on maintenance costs to gain a more thorough understanding of how to better control those costs.

  Or
- Locate the commercial firm that has maximized its maintenance cost controls to see if those techniques might benefit the Air Force.

However, to make this work, the recommendation would be to find an airframe that is utilized by both the Air Force and a commercial organization to ensure validity, reliability and transferability. For instance, the Air Force utilizes the T-43 which is the military version of the commercial Boeing 737. See figure 14 below.

Air Force T-43

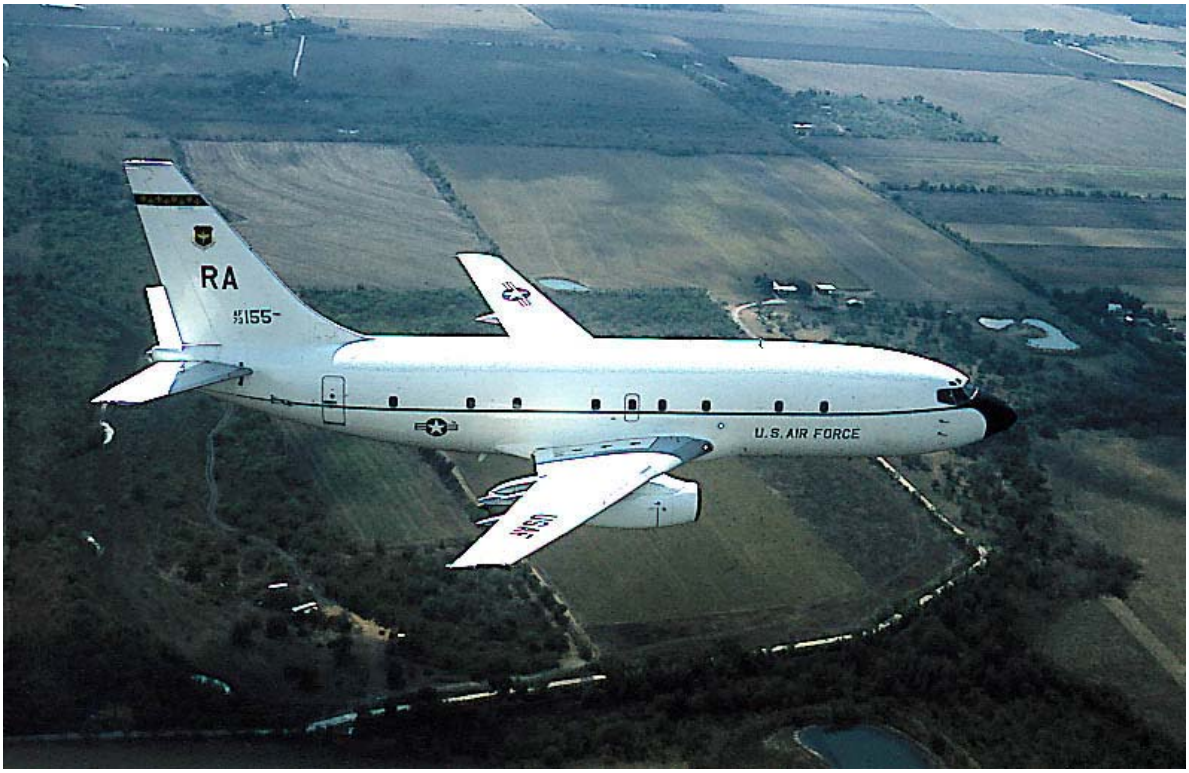


Figure 5. Air Force T-43(Retrieved from the Official Air Force Website, www.af.mil)

The 737 is utilized extensively by the commercial air carrier industry. Southwest Airlines is specifically notable since the 737 is the only airframe it flies. Perhaps this has helped Southwest to realize some efficiencies related to maintenance that the Air Force could benefit from. And as mentioned

previously in Chapter Three, the Air Force's KC-10 Extender is very similar to the civilian version known as the DC-10.

Overview

The purpose of this chapter was to draw conclusions, seek implications for the Air Force and make recommendations for future research. From the broader standpoint, when costs can be controlled and their variability successfully mitigated, future estimating becomes easier and more accurate. Maintenance costs emerged as a common arena that the Air Force shares with the commercial carriers. The air cargo firms interviewed indicated that maintenance ranks high on their list of important costs and requires a great deal of their time and attention. Maintenance costs need to be studied at a more in depth level to discover possible methods or techniques to control this cost more efficiently and effectively.

Appendix A: Definition of Terms

ABC – Activity Based Costing; a technique which involves tracing overhead and direct costs back to specific products and services.

AF/IL-I - The Air Force's Supply Chain Integration & Logistics Transformation Office

AFCAIG – The Air Force Cost Analysis Improvement Group

AFMC – Air Force Material Command headquartered at Wright-Patterson Air Force Base near Dayton, Ohio. The command conducts research, development, test and evaluation, and provides acquisition management services and logistics support necessary to keep Air Force weapons systems at a pre-determined state of readiness.

ALC – Air Logistics Center: provides worldwide engineering, logistics management, depot repair, modifications and maintenance overhauls for Air Force weapons systems (sometimes referred to as the depot).

AVFuel – Aviation Fuel

CC – Two letter designator to indicate an Air Force Commander Function.

CPFH – Cost Per Flying Hour

DLRs – Depot Level Reparables

DoD – Department of Defense

FMS – Foreign Military Sales

GAO – General Accounting Office

GSD – General Support Division

MAJCOM – Major Command

MDS – Mission, Design, Series

PK – Two letter designator to indicate an Air Force Contracting Function

PSCM – Purchasing and Supply Chain Management a strategic, streamlined approach that integrates processes such as demand planning; purchasing; inventory management; supply chain, supplier base management; business practices; and customer relationships.

SSD – System Support Division

TCO – Total Cost of Operations

TWCF – Transportation Working Capital Fund

USTRANSCOM – United States Transportation Command

Appendix B: Data Collection Instruments

Data Collection Instrument & Analysis Methodology

FIRM:_____

POC:_____

Interview Questions

What are the 5 most important costs for this firm? (e.g., fuel, pilot salaries, landing fees)

___ _____

___ _____

___ _____

___ _____

___ _____

How would you rank order these 5 items?

Interview and Data Collection Instrument

FIRM:_____ POC:_____

Issue ID:_____ Rank:_____ Importance:_____

ISSUE - What are the criteria for making this important? (highest dollar value? problem item? hard to get? critical item?

ELEMENT - How is this cost assigned or allocated?

DECISION RULE - How are the cost elements assigned to individual services & transactions?

OUTCOME - What is the result of following this method or utilizing this technique? (What is achieved?)

Bibliography

Air Cargo News. (2004). Patience And Fortitude Fly On A Wing & Prayer At Atlas Retrieved on 11 Mar 2004 from; http://www.air-cargo-news.com/MAD.html

Ayers, J. (2003). Rooting Out Supply-Chain Costs. *Optimize,* 24 (October). Retrieved on 19 Jan 2004 from; http://www.optimizemag.com/issue/024/supplychain_2.htm

Atkinson, A. (1989). Diagnosing Costing Problems. *CMA Magazine, 63*(3), 20.

Beamon, B. (1999). Measuring Supply Chain Performance. *International Journal of Operations & Production Management, 19* (3), 275-292.

Blocher, E., Chen, K. & Lin, T. (2002). *Cost Management: A Strategic Emphasis*. New York: McGraw-Hill.

Bowersox, D., Closs, D., & Cooper, M. (2002). *Supply Chain Logistics Management.* New York: McGraw-Hill.

Bull, L. (2003). DoD wants to extend its authority over depot Work. *Journal of Aerospace and Defense Industry News, 31 January.*

Carr, L. & Ittner, C. (1992). Measuring the cost of ownership. *Journal of Cost Management, 6*(3), 42-51.

Cokins, G. (2001). Measuring costs across the supply chain. *Cost Engineering;* Morgantown, *43*(10), 25-31.

Colorado State University (CSU). (2004) Writing@CSU Online Writing Guide Retrieved on 14 Mar 2004 from: http://writing.colostate.edu/index.cfm

Comments of Atlas Air, Inc. (2003). Consultation Paper With a View To Revision of Regulation Nos. 2407/92, 2408/92 and 2409/92. Retrieved on 12 Mar 2004 from: http://europa.eu.int/comm/transport/air/rules/doc/consultation_3_package/contributions/atlasairinc.pdf

Creswell, J. (2003). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.* Thousand Oaks: Sage Publications, Inc.

Department of the Air Force. *Financial Management: US Air Force Cost and Planning Factors*. AFI 65-503. Washington: HQ USAF, 4 February 1994.

Ellram, L. (1999). The Role of Supply Management in Target Costing. *Center for Advanced Purchasing Studies, Arizona State University.*

Ellram, L. (1994). A taxonomy of total cost of ownership models. *Journal of Business Logistics, 15*(1), 171-191.

Ferrin, B. & Plank, R. (2002). Total cost of ownership models: An Exploratory Study. *Journal of Supply Chain Management, 38*(3), 18-29.

Frazelle, E. (2002). *Supply Chain Strategy: The Logistics of Supply Chain Management.* New York: McGraw-Hill.

Harrington, L. (1995). It's Time to Rethink Your Logistics Costing. *Logisticstoday, 36*(7), 27-30.

Isaac, S. & Michael, W. (1997). *Handbook in Research and Evaluation: A Collection of Principles, Methods and Strategies Useful in the Planning, Design and Evaluation of Studies in Education and the Behavioral Sciences* (3rd ed.). San Diego: Educational & Industrial Testing Services.

LaLonde, B. (2003). Three Problems that Linger. *Supply Chain Management Review, 7*(2), 7-8.

LaLonde, B. & Pohlen, T. (1996). Issues in Supply Chain Costing. *International Journal of Logistics Management, 7*(1), 1-12.

Leedy, P. & Ormrod, J. (2001). *Practical Research: Planning and Design* (7th ed.). Saddle River, NJ: Prentice-Hall, Inc.

Kauffman, R. (2002). Supply Management: What's in a name? Or, do we know who we are? *Journal of Supply Chain Management, 38*(4), 46-50.

MacArthur, J. (1992). Activity-based costing: How many cost drivers do you want? *Journal of Cost Management*, *6*(3), 37-41.

Mena, C., Whicker, L., Templar, S. & Bernon, M. (2002). Costing the Supply Chain. *Manufacturing Engineer, 81*(5), 225-228.

Monczka, R., Trent, R. & Handfield, R. (2002). *Purchasing and Supply Chain Management* (2nd ed.). Cincinnati: South-Western.

Patton, M. (2002). *Qualitative Research & Evaluation Methods* (3rd ed.). Thousand Oaks: Sage Publications, Inc.

PSCM Pillars of Change, Executive Steering Group Meeting PowerPoint Presentation, 29 April 2003.

Rose, P., (1997). Cost per flying hour factors: A background and perspective of how they are developed and what they do. *Air Force Comptroller, 31*(3), 4-6.

Simchi-Levi, D., Kaminsky, P. & Simchi-Levi, E. (2003). *Designing & Managing the Supply Chain* (2nd ed.). New York: McGraw-Hill.

Shelton, F. & Brugh, M. (2002). Indirect Costs of Contracts. *Journal of Construction Accounting and Taxation, 12*(4), 3-9.

Stock, J. & Lambert, D. (2001). *Strategic Logistics Management* (4th ed.). New York: McGraw-Hill.

United States Code. Title 10, Subtitle A, Part IV, Chapter 146, Sec. 2466.

United States General Accounting Office. (2002). *Depot Maintenance: Change in Reporting Practices and Requirements Could Enhance Congressional Oversight* (GAO Publication No. GAO-03-16). Washington, DC: U.S. General Accounting Office.

United States Transportation Command Transportation Working Capital Fund (TWCF) Rate Procedures - Fiscal Year 2003. Retrieved on 13 Mar 2004 from: https://www.amcfm.scott.af.mil/fmb.htm

Vidal, C. & Goetschalskx, M. (2001). A Global Supply Chain Model with Transfer Pricing and Transportations Cost Allocation. *European Journal of Operational Research 129* (2001), 134-158.

Yin, R. (2003). *Case Study Research: Design and Methods* (3rd ed.). Thousand Oaks: Sage Publications.

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14. ABSTRACT

The Air Force has struggled to completely understand the costs associated with its operations. The issue of understanding cost is complex, involving many perspectives, methods and techniques. When examined from a broad standpoint, total supply chain costs can include a firm's costs plus upstream and downstream costs. This perspective takes vendors, suppliers and end customers into consideration. From this broad standpoint, the Air Force does not know its total supply chain cost. Since the Air Force's supply chain is too broad to be a focus of this study, a smaller segment was chosen for a closer look. Specifically, air cargo carriers were selected as a type of commercial organization that could be sufficiently similar to the Air Force in some respects and possibly offer information to address the investigative questions. The purpose of this research is to determine what costing issues exist in the air cargo arena and what costing methods or techniques are utilized to address those issues. Air cargo carriers were contacted and a telephone interview was administered to strategic key informants. The interviews were exploratory, comprised of open-ended questions about how they calculated their cost information, what problems or issues arose from their chosen method and how they addressed those issues. The results of this study may assist the Air Force in determining methods or techniques to address some it's costing issues.

15. SUBJECT TERMS

air cargo firm costing, air transportation costing, air transportation cost allocation

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